



Norfolk Island Pine Culture

Collecting and Storing Seed · Propagating · Growing · Harvesting · Marketing

COOPERATIVE EXTENSION SERVICE

University of Hawaii

Circular 453

Issued in furtherance of Cooperative Extension work, acts of May 8 and June 30, 1914, in cooperation with the U. S. Department of Agriculture. C. Peairs Wilson, Director, Cooperative Extension Service, College of Tropical Agriculture, University of Hawaii, Honolulu, Hawaii 96822.

CIRCULAR 453—MARCH 1972—5M

AUTHORS

This publication was prepared by David T. Fullaway, former State Service Forester, Hawaii Department of Land and Natural Resources, with the assistance of the following:

Tom K. Tagawa, State Forester, Hawaii Department of Land and Natural Resources.

Dr. Eduardo Trujillo, Plant Pathologist, Hawaii Agricultural Experiment Station and Albert Martinez, Extension Plant Pathologist, Cooperative Extension Service, University of Hawaii contributed the section on diseases.

C. J. Davis, Branch Chief, Entomology Branch, Plant Industry Division, Hawaii Department of Agriculture and Dr. A. A. LaPlante, Extension Entomologist, University of Hawaii contributed the section on insects.

Ernest Pung, Service Forester, Hawaii Department of Land and Natural Resources, contributed the section on harvesting and marketing.

To strengthen the Norfolk Island pine Christmas tree industry in Hawaii, today's growers and future producers of this specialized forest crop must be kept up to date on new or better methods of growing and marketing their commodity.

The various steps from cone collecting to packaging and shipping good quality trees require many skills and techniques that were identified, tested, and improved by foresters, entomologists, and pathologists of the State of Hawaii Departments of Land and Natural Resources, Agriculture, and the College of Tropical Agriculture, University of Hawaii.

Clarence Lyman
Specialist in Pasture Management
Cooperative Extension Service
University of Hawaii

TABLE OF CONTENTS

Seed	5
Germination	8
Potting	8
Nursery Care	10
Field Planting	12
Selection of the Site	12
Planting and Maintenance	12
Insect Problems, Symptoms, and Controls	12
Disease Problems, Symptoms, and Controls	14
Cautions	15
Harvesting and Marketing Norfolk Island Pine	15
Bibliography	16

NORFOLK ISLAND PINE CULTURE

Collecting and Storing Seed · Propagating · Growing · Harvesting · Marketing

Norfolk Island Pine, or "Hawaii star pine," *Araucaria heterophylla* (Salisb.) Franco, synonym *A. excelsa* (Lamb.) R. Br., is a native of the South Pacific and was discovered by Captain Cook. Plants were introduced into the Hawaiian Islands during the nineteenth century. There is some confusion about these plants because *A. columnaris* (Forst.) Hook, synonym *A. cookii*, was introduced about the same time, and all spe-

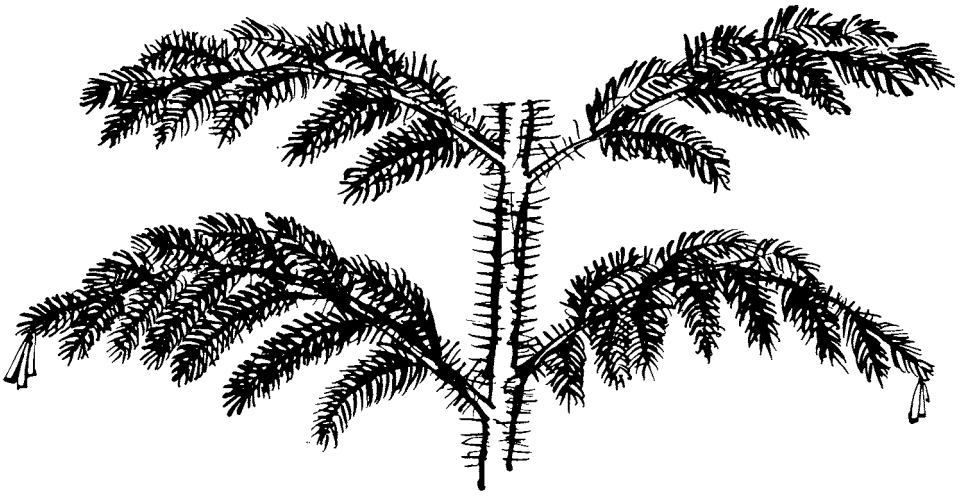
cies are nearly identical in appearance, especially in the early growth stages.

SEED

Norfolk Island pine is a dioecious tree that produces seed cones at 10 to 15 years of age. The seed cones take a full year to mature. The viability or quality of the seed crop depends on the presence of the catkin-like male flowers in sufficient quantities to pollinate the female flowers and the proper weather to allow sufficient quantities of the pollen to disperse to the female flowers at the right time.

Female cones are primarily found in the top 25 percent of the tree.





Male catkins suspended from the tips of the upper branches.

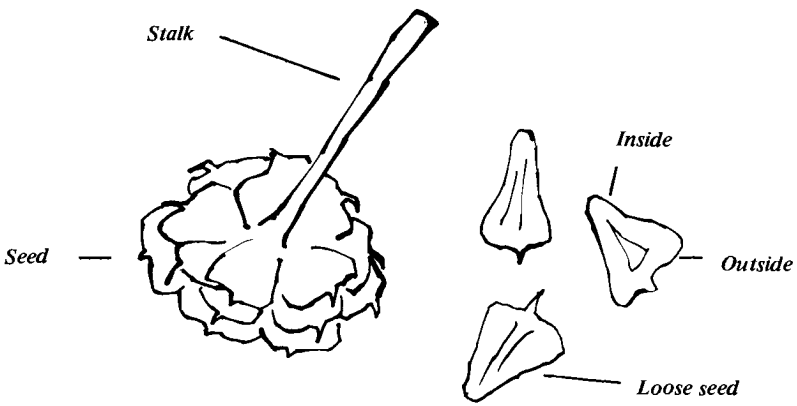
The mature cone is made up of a central stalk and many seed scales. It resembles a pine cone, but the scales have only one seed each while the scales of the true pines bear two seeds.

Seed can be collected by raking them from the ground or by climbing the tree and picking the mature cones. Seed gathered from the ground under the trees have high viability and can be planted immediately; collecting from the ground is safer than climbing, and the seed is relatively dry. Seed collected by climbing requires a great deal of skill in selection to obtain viable seed. Seed obtained is relatively moist and requires drying before storing but it is less expensive to collect. Seed in Hawaii mature from late June through September. The cones are ready for picking from the tree if the cones shatter when they are struck.

The seed should be properly dried for storage by spreading it thinly on a canvas tarp under shelter in a dry, warm section of the island, or in a room in which the temperature and moisture can be controlled. After 1 to 3 weeks of drying, the seed is ready to store in burlap bags at a temperature from 34 to 38 F. To avoid a reduction in seed viability, do not place the seed in a bag or in any bulk container until the seed has been properly dried for storage. The seed should not be frozen, moistened, or heated.

The initial viability of properly collected, handled, dried, and stored seed should be between 70 and 90 percent. Under the best handling and storing conditions the seed will lose about one-half its initial viability every 3 months.

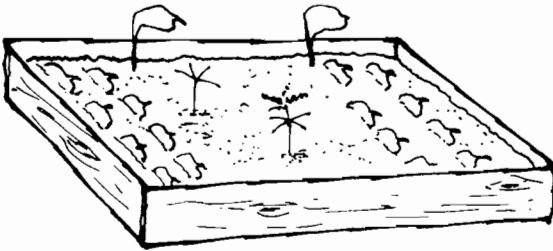
Seed cone



GERMINATION

Maximum germination of the seed can be obtained in a greenhouse with the temperature between 70 and 80 F and with constant moisture. Germination should start in 7 to 10 days and be completed within 21 days. Place the seed in vermiculite in a flat at a 45-degree diagonal position with the upper surface and outside portion of the seed up. If soil or any other medium is used, it should be moistened, fumigated with methyl bromide gas, and aired properly (for 48 hours) prior to use, or it may be heat-sterilized.

Germinating Norfolk Island pine seed.



Flat filled with vermiculite or other germinating medium.



A Norfolk Island pine seedling of good size to be potted. (Actual size)

POTTING

The seedlings will be ready to transplant approximately 10 weeks after the seed germination has ended.

The size and type of pot used in transplanting will vary with the purpose of the operation, the length of time before field planting, the condition of the planting area, the nursery setup and the budget. Some of the available and

usable types of pots are cans, milk cartons, peat pots, drinking cups, plastic tubing, and polyethylene bags. One-gallon containers are adequate to keep trees 1 year or longer in the nursery. A 1-quart container is the minimum size recommended to permit good root development.

The taller and healthier the tree the less planting stock and field maintenance are required in establishing a Christmas tree farm. Therefore, we recommend that the plants be kept in the nursery for 1 year or more. Use fertilizers to push the growth of the potted seedlings. The seedling for field planting should be 12 to 24 inches tall and should have at least three whorls of secondary branches.

The authors believe that nursery costs are lower than field maintenance costs. Vermiculite has been found to be an excellent potting medium when properly fertilized. Other mediums should be fumigated or heat-sterilized prior to use.



Norfolk Island pine seedling ready for field planting.

NURSERY CARE

The seedlings should be grown under greenhouse or shaded conditions. Optimum growing conditions include a temperature of 70 to 80 F; moisture controlled by overhead sprinkler irrigation; overhead shade; raised beds in a nursery designed for easy access and mechanization; a fertilizer, fungicide, and insecticide injection system built into the irrigation system; and frequent light doses of chemicals throughout the nursery phase.

Cull and sort the plants at an early date. If the plants show signs of bronzing (purpling of the primary leaves) or browning and yellowing of the secondary branchlets, sort them and place all the seedlings of each type together by size, shape, or apparent vigor or color. This will give a more uniform nursery and field growth, thus permitting better standardization and mechanization of subsequent maintenance and harvesting.

TABLE 1. Some Chemicals That Can be Used in the Greenhouse in Norfolk Island Pine Culture

Fertilizers	Fungicides	Insecticides
Foliar 63 plus	Dexon	Malathion
Microorganic 5-5-0	Volck Oil	Carbaryl Diazinon Disulfoton Dimethoate

NOTE: Be sure the chemicals used are compatible, and use them according to labels and recommendations.

Some Features To Consider in a Potting Operation

1. Water source.
2. Labor source and quality
3. Transportation – easy access into the nursery with supplies and egress to the field with plants.
4. Growing conditions – controlling the environment.
 - A. Sunlight – use Saran cloth of 50 to 80 percent shade.
 - B. Temperature – use fans and a water screen on the ends of the greenhouse to maintain 70 to 80 F.
 - C. Chemical control – apply fertilizers, fungicides, and insecticides on a regular basis.



Field planting a Norfolk Island pine seedling.

- D. Moisture control — use overhead irrigation with a chemical injection system.
 - E. Growing medium — use vermiculite or steam-sterilized or methyl-bromide-fumigated soil.
5. Mechanization of operations.
- A. Potting.
 - B. Handling — use forklifts, trucks, and nursery design to facilitate movement of plants.
 - C. Shipping — use enclosed trucks.
6. Raised beds and cinder ground cover for easy weed and moisture control. Use shipping skips and cinder blocks to facilitate mechanization.

FIELD PLANTING

Selection of the Site

Norfolk Island pine does not grow well under high intensity or long duration of sunlight; in areas that are too cold (freezing), too wet (more than 160 inches of rain per year), or too dry (less than 20 inches of rain per year). Soils should be well drained.

With the above in mind, the other major factor to consider is the individual site's suitability for mechanized planting, maintenance, and harvest. Sites with level ground and good soil characteristics can generally be mechanized without difficulty.

Planting and Maintenance

Plant spacing should be selected, keeping in mind mechanization of operations. The planting design should allow access to all plants with a tractor and

attachments such as boom spray units, cultivation tools, fertilization attachments, and harvesting units.

Field planting should be done to take advantage of the natural rainy season. Plant quickly and efficiently. Transport seedlings in enclosed trucks, and plant them within an hour after removal from the enclosed truck. Take care to avoid any drying of the plant roots during planting.

The planting hole should be 50 percent larger than the root structure. Commercial fertilizer tablets now available can be placed in the planting hole to stimulate growth of the plant during the first year. Use of these fertilizer tablets or equivalent fertilization practices is recommended.

Application of the proper fertilizers induces tree greening and thus creates a more marketable product.

INSECT PROBLEMS, SYMPTOMS, AND CONTROLS

1. Araucaria aphid, *Neophyllaphis araucariae* Takahashi, is a sap-sucking insect causing devitalization of parts fed upon such as tips of young shoots. These tiny soft-bodied gregarious insects are sometimes called plant lice. Colonies usually are present in young shoots. The araucaria aphid is found on Norfolk Island pine on Kauai, Oahu, Molokai, Maui, and Hawaii. Control of this pest is necessary for plant export. Dimethoate (Cygon, DeFeud) at the rate of 2

TABLE 2. One of Many Possible Field Planting Designs To Facilitate Field Mechanization

X5'	X	10'	X	X	X	X		X	X
X	X	R	X	X	X	X		X	X
		O							
		A							
10'	R O A	D W A Y							
		W							
X	X	A	X	X	X	X		X	X
		Y							
X	X		X	X	X	X		X	X
X	X		X	X	X	X		X	X
5'							10'		
X	X		X	X	X	X	R	X	X
							O		
							A		
							D		
							W		
							A		
							Y		
							10'	R O A	D W A Y
X	X		X	X	X	X		X	X
X	X		X	X	X	X		X	X

1. Spacing is 5 x 5 feet in 16-tree blocks.
2. Roadways are 10 feet wide, providing access from two directions.
3. With this design, the number of seedlings required is 1,120 per acre.
4. Mechanization for tractor use is allowed for with other cultivation tools, booms, and fertilizer attachments.

teaspoons of 23.4% emulsifiable concentrate in each gallon of water (1 quart per 100 gallons) used as a dip gives good and effective control. Another systemic, Disulfoton (Di-Syston), has reportedly been effective in controlling the araucaria aphid but should be used with caution. Read the labels carefully for all pesticides.

2. Armored scale, *Carulaspis giffardi* (Adachi and Fullaway), is a sap-

sucking insect causing the leaves to turn yellow and die. The mature insect is completely covered by a hard shell-like scale. Immature insects are called crawlers. The scales are commonly found in the angles formed by the leaves and stem and are often not visible from the exterior. The armored scale is presently found on all islands. Three other armored scales: *Lindingaspis rossi* (Maskell), *Octaspidotus araucariae*

Adachi and Fullaway, and *Lepidosaphes araucariae* Beardsley have been found infesting Norfolk Island pine in Hawaii. The armored scale can be controlled with dimethoate at the rate of 2 teaspoons of 23.4% emulsifiable concentrate in each gallon of water (1 quart per 100 gallons), or diazinon at the rate of 2 level teaspoons of 50% wettable powder or 1 teaspoon of 50% emulsifiable concentrate in each gallon of water.

3. Pacific beetle cockroach, *Diploptera punctata* (Eschscholtz), gnaws the bark of branches, often completely girdling them, resulting in yellow or dead foliage. The cockroach sometimes is called a beetle roach or Pacific beetle roach due to its resemblance to a beetle. It is present on all islands throughout Hawaii. The cockroach can be controlled with a spray of 1 to 2 teaspoons diazinon emulsifiable concentrate per gallon of water.
4. Araucaria mealybug, *Eriococcus araucariae* Maskell, is a tiny, soft-bodied insect that forms a little oval sac at the base of the needles; the sac of the male is smaller than that of the female. They are found in masses on the terminal part of the twigs. They produce large quantities of honeydew that encourages the growth of sooty mold which, in turn, blackens the infested foliage. This insect is particularly partial to young potted plants. It is present on all the islands. The insect can be controlled with dimethoate at the rate of 2 teaspoons of 23.4% emulsifiable con-

centrate in each gallon of water (1 quart per 100 gallons). Diazinon may also be effective. Caution: dimethoate is a systemic and should be reapplied only when sustained reinfestations occur. Treatment may be effective 1 to 2 months. For potted plants, use 1 pint per 100 gallons (1 teaspoon per gallon).

5. Black twig borer, *Xylosandrus compactus* Eichhoff, is a tiny, brownish black beetle about 1/16 inch long and cylindrical in shape. The head is deflexed downward and bears a pair of short, club-shaped antennae. The tiny beetle larvae are legless and whitish in color. The adult beetles bore tiny holes into the branches and excavate broad chambers where they lay eggs and deposit ambrosia fungus. Infested branches may die as a result of the fungus and beetle activity. The insect is found on Kauai, Oahu, Maui, and Hawaii. Effective control can be obtained with Carbaryl (Sevin) 50% wettable powder at a rate of 4 pounds per 100 gallons of water (1½ tablespoons per gallon of water) applied every 3 or 4 weeks, or malathion 57% emulsifiable concentrate at a rate of 1 quart per 100 gallons of water (2 teaspoons per gallon of water) applied every 3 or 4 weeks.

DISEASE PROBLEMS, SYMPTOMS, AND CONTROLS

1. Root rot, *Phytophthora cinnamomi* Rands, can be of economic importance in the seedling stage. Seedlings affected with this fungus may never

attain marketable size because the pathogen destroys the root system. It is recommended that Christmas tree farms be planted with disease-free stock. Dexon 70% wettable powder used as a dip for plants to be planted in the field at a rate of $\frac{3}{4}$ pound per 10 gallons of water should effectively prevent infection.

2. Needle cast, *Pestalotia* spp. de Not., is a weak parasite that affects the needles when the trees are injured by drought, herbicide, heat, or mechanical means. During shipping, trees stored at high temperatures and humidity can become totally defoliated by the fungus. This problem can be eliminated by proper handling and accurate control of the shipping temperature and humidity.
3. Sooty mold, *Capnodium* spp. Mont., is a fungus induced by honeydew-producing insects. To remove the mold, spray with Volck oil at the rate of 1 gallon in 100 gallons of water (6 tablespoons per gallon). Control of the insect by the use of the proper insecticide will prevent recurrence of the conditions needed for the mold to exist.

CAUTIONS

1. You are dealing with plants, and anything and everything that you do, even slightly wrong at any stage, will result in loss. *Do things right.*
2. Establish your market first and continue to build your market at all times.
3. Remember that different states require various treatments for entry of plant material.

4. Regulations concerning insecticides are being modified. Some of those mentioned here may be found subject to new limitations on sale or use.

For clarity, trade names have been used in some cases. This is not an endorsement of a particular brand or product nor is it intended to discriminate against similar products not mentioned by name.

HARVESTING AND MARKETING

Norfolk Island pine Christmas trees are harvested manually with either a hand or light-weight power saw. The trees are harvested by selective-cut method, taking special care to cut only the good quality trees. Selected trees should be firm, yet green and lush. As a prerequisite to market development, growers should avoid placing yellowish and poorly formed trees onto the market.

Small growers usually market their trees on a "you-cut basis"; large growers are required to harvest, package, and ship their trees, usually to wholesale centers where the trees are distributed to retail dealers. One large grower selects and marks his trees a month before the harvesting season. This method gives him an accurate inventory of his marketable trees by size and class and also helps to hasten the harvest during the short, hectic cutting period. The trees are hand-carried out of the field and grouped beside the road.

Trees are packed by a crew of two. One picks up the tree, inserts it, butt end first, through a homemade funnel that bends and compresses the branches upward and toward the central stem,

making it possible for the tree to fit into a rolled-up perforated plastic sleeve attached to the small end of the funnel. The other worker pushes his arm through the sleeve, grasps the base of the tree and pulls it through. It takes about 10 seconds to package a tree. Rolls of sleeve materials are available in various diameters or sizes. Take care to prevent excessive squeezing which is apt to damage the basal branches. Damage can be lessened also by adjusting the size of the funnel or using funnels of different sizes.

During transit, the packed trees should not be piled more than six deep, usually with the larger trees on the bottom of the stack. Store trees in an upright position. Upright storage lends itself to easier handling and also reduces terminal breakage and tree deformation.

Mainland air freight rates are regressive. The rate for up to 1,000 pounds is \$.71 per pound, and \$.19 per pound for 1,000 or more pounds. It takes an assortment of 75 to 80 trees of heights between 5 and 8 feet to make a shipment of 1,000 pounds. An average 6-foot tree weighs between 12 and 15 pounds. A healthy 8-footer weighs up to 25 pounds. Inter-island barge rates to Honolulu from the neighbor islands are less expensive than air, and the barges are able to handle bulk shipments.

In the Hawaii island production areas, Norfolk Island pine Christmas trees wholesale at \$.50 to \$.60 per foot and retail from \$.90 to \$1.00 per foot. Large trees, more than 8 feet tall, retail at \$2.00 to \$2.50 per foot. In Seattle, Washington, a 4-foot Norfolk Island pine Christmas tree from Hawaii retails

for \$9.95. Trees 6-feet tall retail at \$15.45, and 8-foot trees at \$23.95 each.

In 1969, approximately 9,000 trees were shipped to the West Coast, and 25,000 were marketed locally. The 1969 shipping strike was the primary reason for the large local consumption.

In early 1971, approximately 250 acres were planted to Norfolk Island pines for Christmas tree management in the State of Hawaii.

Current problems faced by the Norfolk Island pine Christmas tree industry include: 1) lack of adequate seedling supplies for planting and replanting; 2) a need for simple methods to harden-off marketable trees to minimize or prevent the terminal and branch drooping that often takes place within a day after harvest; 3) excessive breakage during packing, shipment, and storage; 4) high shipping costs; and 5) inadequate shipping and storage facilities and the need for excessive handling.

Good common sense in harvesting, packing, shipping, storing and marketing can overcome most of the problems listed above.

REFERENCES

1. Bailey, L. H. 1963. *The standard cyclopedia of horticulture*. The Macmillan Company, N.Y. pp. 345-347
2. Crawford, H. E. *Norfolk Island pine*. Unpublished Paper, Hilo, Hawaii, 6pp.
3. Dow, Peter B. 1969. Personal communication, Seedsman, New Zealand.
4. Neal, Marie C. 1965. *In gardens of Hawaii*. Bernice P. Bishop Museum Special Publication 50. pp. 35-39